Syllabus – Microelectronics Manufacturing and the Environment

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Department of Chemical & Environmental Engineering

CHEE, MSE & ECE 415 & 515

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Course Description

• This course will focus on the presentation of basic semiconductor fabrication unit operations as they relate to:
  
  – Theory of operation
  – Materials
  – Equipment
  – Fabrication processes
  – Key environmental impacts and challenges

• Prerequisites:
  – None
Instructor Information

• Instructor:
  – Name: Ara Philipossian
  – Office: Electrical & Computer Engineering Building, Room 223
  – Phone: 520 621 6101
  – E-Mail: ara@engr.arizona.edu

• Office Hours:
  – TBD
  – There will be no TA for this course
  – Other times by appointment only (send me an e-mail please)
  – Office hours are subject to change
Method of Instruction

• Class location: TBD – Class meets once a week for 2½ hours with an additional 10 minute break in between.

• Course will be delivered in the form of traditional lectures as well as instructional videos:
  - Prof. Ara Philipossian (UA – Lectures)
  - Prof. Farhang Shadman (UA – Video)
  - Dr. Michael Goldstein (Intel – Video)
  - Prof. Srini Raghavan (UA – Video)
  - Dr. Robert Meagley (Intel – Video)
  - Dr. Larry Larsen (Sematech – Video)

• Self-discipline will be paramount in order to keep up with the pace and the volume (and format) of information delivered.
Method of Instruction (continued)

• Homework:
  – Twenty or so assignments

• Exams:
  – Mid-Term No. 1
  – Mid-Term No. 2

• Group Project Proposal (Written and Oral):
  – Please see the next 5 slides
Project Proposal

• ORAL PRESENTATION AND SUBMISSION DEADLINE
  – Due date: TBD
  – Deliver a hardcopy to Ara Philipossian in the class
  – Present to the entire class (no more than 10 minutes and 9 PPT slides)

• WRITTEN PROPOSAL LENGTH
  – No more than 14 pages including figures and list of references
  – Keep it crisp and to the point
  – Font size: 11
  – Spacing: Double

• MAXIMUM OF 5 STUDENTS PER GROUP
Project Proposal (continued)

• FOCUS AREAS
  – Process consumables replacement
  – Process consumables reduction
  – Process consumables re-use

• TOPICS TO CHOOSE FROM
  – Electroplating of copper
  – CMP of copper or dielectrics
  – CMP of Shallow Trench Isolation
  – Thermal oxidation
  – LPCVD of dielectrics
  – LPCVD of tungsten
  – Wet cleaning and surface preparation
  – Dry cleaning & surface preparation
  – Rinsing
  – Drying
  – Post-CMP cleaning
TOPICS TO CHOOSE FROM (CONTINUED)

- Wet etching of silicon nitride or silicon dioxide
- Dry etching of silicon dioxide
- PVD of copper
- Plasma etching
- Lithography

RESEARCH OBJECTIVE

- What problem are you solving?
- What opportunities are you suggesting to be exploited?
- What technology or usage issues motivate this problem?
- What has been done in this area in the past?
- How does your proposed work differ from what’s already been done by other researchers?
- What is your research hypothesis?
- How will you verify that hypothesis?
- What is the potential impact on industry practice if the hypothesis is verified?
• RELATIONSHIP TO OTHER RESEARCH OR PRACTICE
  – What similar research to this proposal is being conducted by other universities?
  – How does this proposal differ from that research

• RESEARCH POTENTIAL IMPACT
  – What concrete results are expected?
  – How could those results be put into practice?
  – How could an IC manufacturer benefit from the completion of this work?
  – What technological advances must happen for that benefit to be realized?

• RESEARCH PLAN (ASSUME A 2-YEAR DURATION)
  – Deliverables
  – Timeline
  – Technical tradeoffs that may have to be made
  – Risks in this research and how they will be managed
• **BIBLIOGRAPHY**

  – Roughly 10 publications relating to state-of-the-art and your proposed work
  – Attach hardcopies of all referenced publications and submit it with your report (note that these pages are in addition to the 14 pages containing your report)

• **GRADING**

  – Your grade will be based on the following:
    • Creativity
    • Originality
    • Aesthetics & professionalism of the report
    • Impact to industry
    • Completeness & relevance of previous work cited in the bibliography and your ability to structure your proposal recognizing what’s been done before by other researchers
    • Likelihood of success of your proposal
YOUR Final Grade

- Homework: ZERO – I will not be collecting or grading any of the HWs. I will post all solutions on D2L.
  Exams will be based on HW

- Mid-Term Exam 1: 30%
- Mid-Term Exam 2: 40%
- Proposal: 30%
Books

• Required Textbook:
  

• Recommended Books:
  
  
  
  
  
Groundrules

• There will be no make-up exams whatsoever

• Turn off all mobile devices in the classroom

• Lectures start promptly
  – Please be on time
  – Students arriving more than 5 minutes late are requested to wait outside the classroom. Late students will be admitted into the classroom when there is a natural break in the lecture.
  – Being 5 minutes late means:
    • (5 minutes) x (29 students + 1 instructor)
    • 2½ hours of other people’s time wasted
  – If you miss a lecture, please do not ask me for a tutorial on the subjects covered during the lecture

• Complete your reading assignment prior to each lecture
Groundrules (continued)

• Please do not seek the instructors’ help in solving homework problems if you have not given the problem your best shot.

• You need to kindly show the instructor in writing your logic and deductive reasoning in attempting to solve a problem before the instructor proceeds to help you.
Course Structure – Subject to Change

• Lecture No. 1 by Ara Philipossian
  – Review of the Syllabus
  – Introduction to Device Fabrication
  – Introduction to Design for the Environment
  – Silicon Wafer Manufacturing – Part 1
  – Silicon Wafer Manufacturing – Part 2 (Please watch the video on D2L ASAP)

• Lecture No. 2 by Ara Philipossian
  – Impurity Diffusion
  – Thermal Oxidation
Course Structure

• Lecture No. 3 by Ara Philipossian
  – Thermal oxidation (continued)
  – Dielectric Deposition

• Lecture No. 4 by Ara Philipossian, Srini Raghavan and Larry Larsen
  – Low k Dielectrics
  – Ion Implantation (by Larry Larson – Please watch the video on D2L ASAP)
  – You need to download SRIM in order to solve the Implantation HW problems.

• Review Lectures (Nos. 5 and 6) by Ara Philipossian

Mid-Term Exam 1 … Date TBD (duration = 2½ hours)
Course Structure

• Lecture No. 7 by Ara Philipossian
  – Wet Etching, Cleaning and Surface Preparation
  – Drying (by Srini Raghavan – Please watch video on D2L ASAP)

• Lectures No. 8 and 9 by Ara Philipossian
  – Chemical Mechanical Planarization (Parts I and II)

• Lecture No. 10 by Ara Philipossian, Farhang Shadman, Michael Goldstein and Robert Meagley – Watch litho and metallization videos on D2L.
  – Lecture on the elements of the final proposal plus Q & A
  – Ultra-Pure Water Production, Use and Re-Use
  – Rinsing
  – Photolithography
  – Metallization
Course Structure

- Review Lecture (No. 11) by Ara Philipossian
- Proposal Presentations (written proposal due today in class)!

Mid-Term Exam 2 … Date TBD (duration = 2½ hours)